

CLAIMS

1. A method for the prevention or for the treatment of

5 – pathologies associated with the presence, in the body of an individual, of an exogenous or endogenous protein capable of being directly or indirectly involved in the process of appearance and/or development of these pathologies, or

10 – pathologies involving the molecules of the major histocompatibility complex and/or the T cell receptors,

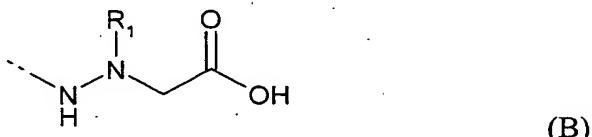
15 – pathologies associated with the presence in the body of an individual of an antibody capable of being recognized by a hybrid peptide, or for the *in vitro* diagnosis of the aforesaid pathologies comprising the administration of a pharmaceutically acceptable amount of hybrid peptides analogues of peptides or parent proteins, these hybrid peptides containing at least one aza- β^3 aminoacyl residue, namely :

* a residue corresponding to the following formula (A) when it is situated in the N-terminal position,



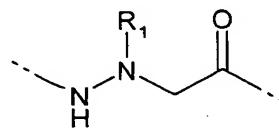
20 wherein R represents H or a protective group of the amine function of the amino acids, such as Fmoc, Boc, or Z, and R₁ represents a side-chain selected from those of the amino acids,

25 * a residue corresponding to the following formula (B) when it is situated in the C-terminal position,



wherein R₁ represents a side-chain selected from those of the amino acids,

30 * a residue corresponding to the following formula (C) when it is situated in the chain of the said hybrid peptides,



(C)

wherein R₁ represents a side-chain selected from those of the amino acids.

5 2. The method according to claim 1, for the prevention or for the treatment of pathologies of viral or bacterial origin, or of autoimmune pathologies, or of neurodegenerative diseases.

10 3. The method according to claim 1, for the prevention or for the treatment of the following pathologies:

• pathologies involving molecules of the major histocompatibility complex and/or the T cell receptors,

15 • autoimmune diseases, and in particular Hashimoto thyroiditis, Basedow's disease, Addison's disease, pituitary insufficiency, Biermer's gastritis, certain forms of sterility, type 1 juvenile diabetes, Goodpasture's syndrome, myasthenia, acute articular rheumatism, pemphigus, bullous pemphigoid, herpetiform dermatitis, vitiligo, alopecia, psoriasis, sympathetic ophthalmia, uveitis, Guillain-Baré's syndrome, multiple sclerosis, haemolytic anaemia, idiopathic thrombocytopenic purpura, idiopathic leucopaenia, primary biliary cirrhosis, active chronic hepatitis, ulcerative colitis, Crohn's ileitis, 20 Gougerot-Sjögren syndrome, rheumatoid polyarthritis, dermatopolymyositis, scleroderma, mixed connective tissue disease, discoid lupus erythematosus and systemic lupus erythematosus,

• neurodegenerative diseases,

• diseases of viral origin, in particular:

25 – AIDS caused by human immunodeficiency virus HIV-1 and HIV-2,

– paraplegia associated with HTLV-1, or adult T cell leukaemia, caused

by human T cell leukaemia virus (HTLV virus),

– infections caused by the syncytial respiratory virus,

– infections caused by the Coxsackie virus, for example acute

30 lymphocytic meningitis,

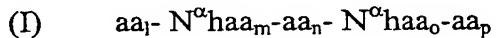
– infections caused by the Epstein-Barr virus, for example infectious

mononucleosis,

- infections caused by the cytomegalovirus, for example cytomegalic inclusion disease,
- herpes caused by the human herpes virus,
- herpes caused by the herpes simplex virus 6,
- infections caused by the human parvovirus B19, for example infectious gastroenteritis,
- hepatitis B caused by the hepatitis B virus,
- hepatitis C caused by the hepatitis C virus,
- influenza caused by the influenza virus,
- rubella caused by the rubella virus,
- infections caused by the Dengue virus, for example the arboviroses,
- colds, rhinitis and coryza caused by the rhinoviruses,
- aphthous fever caused by aphthous fever virus,
- certain cancers linked with viruses, such as the papilloma viruses.

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4. The method according to claim 1, comprising the administration of a pharmaceutically acceptable amount of hybrid peptides of the following formula (I) :



wherein :

20

- aa_1 , aa_n and aa_p represent an aminoacyl residue, or a concatenation of aminoacyl residues, corresponding to the aminoacyl residues present at the same positions in the peptide or the parent protein from which the hybrid peptides are derived,

25

- $N^{\alpha}haa_m$ and $N^{\alpha}haa_o$ represent an aza- β^3 aminoacyl monomer residue, or a concatenation of aza- β^3 aminoacyl monomer residues analogous to the aminoacyl residues initially present at the same position in the peptide or the parent protein from which the hybrid peptides are derived, the said aza- β^3 aminoacyl monomers corresponding to the formulae (A), (B), or (C) shown in claim 1, depending on whether they are respectively in the N-terminal or C-terminal position, or in the chain of the said hybrid peptides, and wherein R_1 is identical to the side-chain of the initial amino acid of the peptide or of the parent protein to which the said aza- β^3 aminoacyl monomers correspond,

30

- 1, m, n, o, and p represent zero, or a whole number lying between 1 and 20, provided that at least one of m or o is different from zero, and that the minimum number of residues in the said hybrid peptides of formula (I) is 4.

5 5. The method according to claim 1, for the prevention or for the treatment of systemic lupus erythematosus, comprising the administration of a pharmaceutically acceptable amount of hybrid peptides derived from the epitope 88-99 of the histone H4 as parent peptide, and corresponding to SEQ ID NO : 1, at least one of whose initial amino acids is replaced by an aza- β^3 amino acid analogue residue.

10

6. The method according to claim 1, for the prevention or for the treatment of systemic lupus erythematosus, comprising the administration of a pharmaceutically acceptable amount of hybrid peptides of the following formulae:

– SEQ ID NO : 2 (or peptide E) :

15 $^{88}\text{H}_2\text{N-Tyr-Ala-Leu-Lys-Arg-Gln-Gly-Arg-Thr-N}^{\alpha}\text{-hLeu-Tyr-Gly-OH}^{99}$

– SEQ ID NO : 3 (or peptide C) :

88 $\text{H}_2\text{N-Tyr-Ala-N}^{\alpha}\text{-hLeu-Lys-Arg-Gln-Gly-Arg-Thr-Leu-Tyr-Gly-OH}^{99}$

– SEQ ID NO : 4 (or peptide A) :

88 $\text{H}_2\text{N-Tyr-N}^{\alpha}\text{-hAla-Leu-Lys-Arg-Gln-Gly-Arg-Thr-Leu-Tyr-Gly-OH}^{99}$

20 – SEQ ID NO : 5 (or peptide B) :

88 $\text{H}_2\text{N-Tyr-N}^{\alpha}\text{-hAla-N}^{\alpha}\text{-hLeu-Lys-Arg-Gln-Gly-Arg-Thr-Leu-Tyr-Gly-OH}^{99}$

– SEQ ID NO : 6 (or peptide D) :

88 $\text{H}_2\text{N-Tyr-Ala-Leu-N}^{\alpha}\text{-hLys-Arg-Gln-Gly-Arg-Thr-Leu-Tyr-Gly-OH}^{99}$

– SEQ ID NO : 7 (or peptide G) :

25 88 $\text{H}_2\text{N-Tyr-Ala-Leu-Lys-Arg-Gln-Gly-Arg-Thr-N}^{\alpha}\text{-hLeu-N}^{\alpha}\text{-hTyr-Gly-OH}^{99}$

– SEQ ID NO : 8 :

88 $\text{H}_2\text{N-Tyr-Ala-Leu-Lys-Arg-Gln-N}^{\alpha}\text{-hGly-Arg-Thr-Leu-Tyr-Gly-OH}^{99}$

– SEQ ID NO : 9 :

88 $\text{H}_2\text{N-Tyr-Ala-Leu-Lys-Arg-Gln-Gly-N}^{\alpha}\text{-hArg-Thr-Leu-Tyr-Gly-OH}^{99}$

30 – SEQ ID NO : 10 :

88 $\text{H}_2\text{N-Tyr-Ala-Leu-Lys-N}^{\alpha}\text{-hArg-Gln-Gly-Arg-Thr-Leu-Tyr-Gly-OH}^{99}$

– SEQ ID NO : 11 :

88 $\text{H}_2\text{N-Tyr-Ala-Leu-Lys-Arg-Gln-Gly-Arg-Thr-Leu-N}^{\alpha}\text{-hTyr-Gly-OH}^{99}$

– SEQ ID NO : 12 :

⁸⁸H₂N-N^α-hTyr-Ala-Leu-Lys-Arg-Gln-Gly-Arg-Thr-Leu-Tyr-Gly-OH⁹⁹

– SEQ ID NO : 13 :

⁸⁸H₂N-Tyr-Ala-Leu-Lys-Arg-Gln-Gly-Arg-Thr-Leu-Tyr-N^α-hGly-OH⁹⁹

– SEQ ID NO : 14 :

⁸⁸H₂N-Tyr-Ala-Leu-Lys-Arg-Gln-Gly-Arg-Thr-N^α-hLeu-N^α-hTyr-N^α-hGly-OH⁹⁹

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7. The method according to claim 1, for the prevention or for the treatment of systemic lupus erythematosus, comprising the administration of a pharmaceutically acceptable amount of the hybrid peptide of formula SEQ ID NO : 2, or of the hybrid peptide of formula SEQ ID NO : 7.

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8. The method according to claim 1, for the prevention or for the treatment of influenza or of any other pathology for which a molecule containing a B or CTL (CD8) epitope is administered in combination with the sequence 307-319 HA which contains a so-called universal T CD4 epitope comprising the administration of a pharmaceutically acceptable amount of hybrid peptides derived from the peptide 307-319 of the haemagglutinin of the influenza virus as parent peptide, and corresponding to SEQ ID NO : 15, at least one of whose initial amino acids is replaced by an aza-β³ amino acid analogue residue.

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9. The method according to claim 1, for the prevention or for the treatment of influenza or of any other pathology for which a molecule containing a B or CTL (CD8) epitope is administered in combination with the sequence 307-319 HA which contains a so-called universal T CD4 epitope comprising the administration of a pharmaceutically acceptable amount of hybrid peptides of the following formulae:

– SEQ ID NO : 16 (or peptide A') :

³⁰⁷H₂N-N^α-hPro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

30

– SEQ ID NO : 17 (or peptide B') :

³⁰⁷H₂N-Pro-N^α-hLys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

– SEQ ID NO : 18 (or peptide C') :

³⁰⁷H₂N-Pro-Lys-N^α-hTyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

– SEQ ID NO : 19 (or peptide D') :

³⁰⁷H₂N-Pro-Lys-Tyr-N^α-hVal-Lys-Gln-Asn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

– SEQ ID NO : 20 (or peptide E') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-N^α-hLys-Gln-Asn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

5 – SEQ ID NO : 21 (or peptide F') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-N^α-hLeu-Lys-Leu-Ala-Thr-OH³¹⁹

– SEQ ID NO : 22 (or peptide G') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-N^α-hLys-Leu-Ala-Thr-OH³¹⁹

– SEQ ID NO : 23 (or peptide H') :

10 ³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-N^α-hAsn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

– SEQ ID NO : 24 (or peptide I') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-N^α-hLeu-Ala-Thr-OH³¹⁹

– SEQ ID NO : 25 (or peptide J') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-Leu-N^α-hAla-Thr-OH³¹⁹

15 – SEQ ID NO : 26 (or peptide K') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-N^α-hLys-N^α-hLeu-N^α-hAla-Thr-OH³¹⁹

– SEQ ID NO : 27 (or peptide L') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-N^α-hLeu-N^α-hAla-Thr-OH³¹⁹

20 10. The method according to claim 1, for the prevention or for the treatment of influenza or of any other pathology for which a molecule containing a B or CTL (CD8) epitope is administered in combination with the sequence 307-319 HA which contains a so-called universal T CD4 epitope comprising the administration of a pharmaceutically acceptable amount of the hybrid peptide of formula SEQ ID NO : 25.

25 11. Hybrid peptides containing at least one aza-β³ amino acid, these hybrid peptides being analogues of peptides or parent proteins, the said hybrid peptides containing at least one initial amino acid of the peptide or of the parent protein.

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12. Hybrid peptides according to claim 11, of the following formula (I):

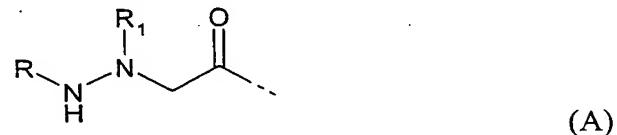
(I) aa₁-N^αhaa_m-aa_n-N^αhaa_o-aa_p

wherein :

— aa_1 , aa_n and aa_p represent an aminoacyl residue, or a concatenation of aminoacyl residues, corresponding to the aminoacyl residues present at the same positions in the peptide or the parent protein from which the hybrid peptides are derived,

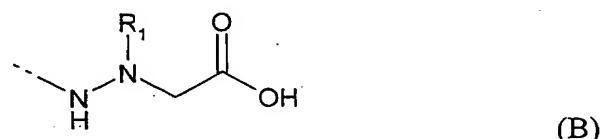
— $N^\alpha haa_m$ and $N^\alpha haa_o$ represent an aza- β^3 aminoacyl monomer residue, or a concatenation of aza- β^3 aminoacyl monomer residues, analogous to the aminoacyl residues initially present at the same position in the peptide or the parent protein from which the hybrid peptides are derived, the said aza- β^3 aminoacyl monomers corresponding to

* the following formula (A) when it is situated in the N-terminal position,



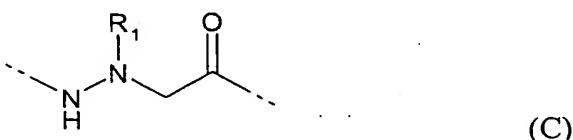
wherein R represents H or a protective group of the amine function of the amino acids, such as Fmoc, Boc, or Z, or

* the following formula (B) when it is situated in the C-terminal position,



or

* the following formula (C) when it is situated in the chain of the said hybrid peptides,

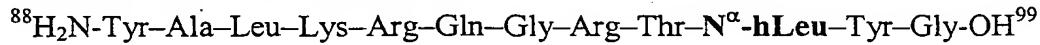


wherein R₁ is identical to the side-chain of the initial amino acid of the peptide or of the parent protein to which the said aza- β^3 aminoacyl monomers correspond,

5 – l, m, n, o and p represent zero, or a whole number lying between 1 and 20, provided that one at least of m or o is different from zero, that the minimum number of residues in the said hybrid peptides of formula (I) is 4, and one at least of l, n, or p is different from zero.

13. Hybrid peptides according to claim 11, of the following formulae:

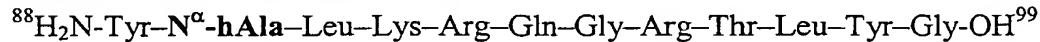
– SEQ ID NO : 2 (or peptide E) :



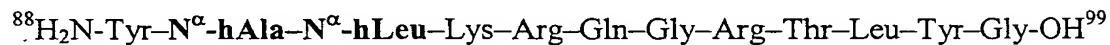
– SEQ ID NO : 3 (or peptide C) :



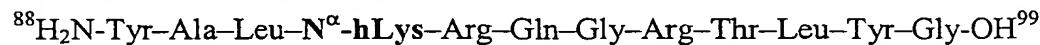
– SEQ ID NO : 4 (or peptide A) :



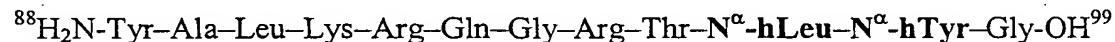
– SEQ ID NO : 5 (or peptide B) :



– SEQ ID NO : 6 (or peptide D) :



– SEQ ID NO : 7 (or peptide G) :



– SEQ ID NO : 8 :



– SEQ ID NO : 9 :



– SEQ ID NO : 10 :



– SEQ ID NO : 11 :



– SEQ ID NO : 12 (or peptide F) :



– SEQ ID NO : 13 (or peptide H) :



– SEQ ID NO : 14 (or peptide I) :

⁸⁸H₂N-Tyr-Ala-Leu-Lys-Arg-Gln-Gly-Arg-Thr-N^α-hLeu-N^α-hTyr-N^α-hGly-OH⁹⁹

- SEQ ID NO : 16 (or peptide A') :

³⁰⁷H₂N-N^α-hPro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

- SEQ ID NO : 17 (or peptide B') :

³⁰⁷H₂N-Pro-N^α-hLys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

- SEQ ID NO : 18 (or peptide C') :

³⁰⁷H₂N-Pro-Lys-N^α-hTyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

- SEQ ID NO : 19 (or peptide D') :

³⁰⁷H₂N-Pro-Lys-Tyr-N^α-hVal-Lys-Gln-Asn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

- SEQ ID NO : 20 (or peptide E') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-N^α-hLys-Gln-Asn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

- SEQ ID NO : 21 (or peptide F') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-N^α-hLeu-Lys-Leu-Ala-Thr-OH³¹⁹

- SEQ ID NO : 22 (or peptide G') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-N^α-hLys-Leu-Ala-Thr-OH³¹⁹

- SEQ ID NO : 23 (or peptide H') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-N^α-hAsn-Thr-Leu-Lys-Leu-Ala-Thr-OH³¹⁹

- SEQ ID NO : 24 (or peptide I') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-N^α-hLeu-Ala-Thr-OH³¹⁹

- SEQ ID NO : 25 (or peptide J') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-Leu-N^α-hAla-Thr-OH³¹⁹

- SEQ ID NO : 26 (or peptide K') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-N^α-hLys-N^α-hLeu-N^α-hAla-Thr-OH³¹⁹

- SEQ ID NO : 27 (or peptide L') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-N^α-hLeu-N^α-hAla-Thr-OH³¹⁹

14. Hybrid peptides according to claim 11, of the following formulae:

- SEQ ID NO : 2 (or peptide E) :

⁸⁸H₂N-Tyr-Ala-Leu-Lys-Arg-Gln-Gly-Arg-Thr-N^α-hLeu-Tyr-Gly-OH⁹⁹

- SEQ ID NO : 7 (or peptide G) :

⁸⁸H₂N-Tyr-Ala-Leu-Lys-Arg-Gln-Gly-Arg-Thr-N^α-hLeu-N^α-hTyr-Gly-OH⁹⁹

- SEQ ID NO : 25 (or peptide J') :

³⁰⁷H₂N-Pro-Lys-Tyr-Val-Lys-Gln-Asn-Thr-Leu-Lys-Leu-N^α-hAla-Thr-OH³¹⁹

15. Polyclonal or monoclonal anti-hybrid peptide antibodies such as obtained by immunization of an animal with at least one hybrid peptide defined in claim 1, the said antibodies being capable of forming a complex with these hybrid peptides, and/or with the peptides or parent proteins corresponding to these latter, and characterized in that they recognize the parent peptide or the parent protein with an affinity at least equal to that displayed by the anti-parent peptide or anti-parent protein antibodies towards the parent peptide or the parent protein.

10 16. Anti-idiotype antibodies capable of forming a complex with polyclonal or monoclonal anti-hybrid peptide antibodies such as obtained by immunization of an animal with at least one hybrid peptide defined in claim 1, the said anti-hybrid peptide antibodies being capable of forming a complex with these hybrid peptides, and/or with the peptides or parent proteins corresponding to these latter, and characterized in that they recognize the parent peptide or the parent protein with an affinity at least equal to that displayed by the anti-parent peptide or anti-parent protein antibodies towards the parent peptide or the parent,
15 such as obtained by immunization of an animal with the said polyclonal or monoclonal anti-hybrid peptide antibodies.

20 17. A complex between a hybrid peptide such as defined in claim 1, and an element of the major histocompatibility complex (also referred to as MHC-hybrid complex), and possibly a T cell receptor (also referred to as MHC-hybrid-T receptor complex).

25 18. A complex between a hybrid peptide such as defined in claim 1, and a T cell receptor.

30 19. A method for the *in vitro* diagnosis of pathologies associated with the presence in the body of a patient, of an exogenous or endogenous protein, capable of being directly or indirectly involved in the process of appearance and/or development of these pathologies, characterized in that it comprises:

– contacting a biological sample deriving from a patient capable of being a carrier of antibodies directed against the said protein, with a hybrid peptide such as

defined in claim 1, the said hybrid peptide being derived from all or part of the said endogenous or exogenous protein, or derived from a peptide capable of being recognized by antibodies themselves recognizing the exogenous or endogenous protein,

under conditions allowing the reaction between the antibodies directed against the protein and capable of being present in the biological sample, and the aforesaid hybrid peptide,

– the *in vitro* detection of the antigen / antibody complex capable of being formed in the preceding stage or

– the *in vitro* detection of antibodies circulating in the patient by a competitive test using an anti-hybrid antibody.

20. A method for the *in vitro* diagnosis of pathologies associated with the presence in the body of a patient of an exogenous or endogenous protein capable of being directly or indirectly involved in the process of appearance or development of these pathologies, the said method being characterized in that it comprises:

– contacting a biological sample deriving from a patient capable of being a carrier of the said protein with at least one of the polyclonal or monoclonal anti-hybrid peptide antibodies, such as obtained by immunization of an animal with at least one hybrid peptide defined in claim 1, the said antibodies being capable of forming a complex with these hybrid peptides, and/or with the peptides or parent proteins corresponding to these latter, and characterized in that they recognize the parent peptide or the parent protein with an affinity at least equal to that displayed by the anti-parent peptide or anti-parent protein antibodies towards the parent peptide or the parent protein, said antibodies being advantageously directed against a hybrid peptide derived from all or part of the said endogenous or exogenous protein, or

under conditions allowing the reaction between the protein capable of being present in the biological sample, and the aforesaid antibodies directed against the aforesaid hybrid peptide;

– the *in vitro* detection of the antigen / antibody complex capable of being formed in the preceding stage, or

– the detection of antigens circulating in the patient in competitive tests using a hybrid peptide such as defined in claim 1.